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Health and water quality study of the Parkway Belt subdivision in the town of Dundas

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Introduction

In Ontario, provision of a piped water supply is a regional government responsibility with property owner financial participation. The Parkway Belt (Pleasant View) area of the Town of Dundas was first settled in the 19th century and now is a suburban area without piped water. The three square kilometer area is bounded by the Royal Botanical Gardens to the south, highway number six to the east, the Niagara Escarpment to the north and Valley Road to the west. According to a Hamilton-Wentworth Planning and Development Department report (Underwood McCellen 1984), the groundwater acquifer and individual yield of water from wells are not adequate to serve present development in this area. Sixty-seven percent of residents have their water trucked in and stored in cisterns on their property. This costs residents approximately $360 per year. The trucker lives in the Parkway Belt area. Installation of piped water will be very costly -- approximately $3.5 million (Hamilton-Wentworth Department of Engineering 1986).

The Mayor of Dundas and the Member of the Legislative Assembly of the provincial electoral riding in which the Parkway Belt is located have pointed out that the regional government costs to install piped water could be offset by Ministry of Environment support. However, two Planning and Development Department reports (Underwood and McLellen 1984 and UMA Engineering 1985) found that the present septic tank and tile systems of sewage disposal in over 35 existing homes in Parkway Belt would be inadequate to handle piped water. The installation of piped water is recommended only if sewage disposal in the area is upgraded. The present runoff from these 35 homes is in danger of causing serious soil erosion. The problem of soil erosion is of particular concern in the ravine areas that pass eventually through the railway line that borders the Parkway Belt area. Sewage disposal upgrading costs would be high and would be in addition to the estimated $3.5 million piped water costs.

In 1986, the Town of Dundas requested the Department of Health Services of the Regional Municipality of Hamilton-Wentworth to determine whether the present water supply and sewage disposal methods used in the Parkway Belt area pose a threat to the health of its residents. Evidence from a Department of Health Services study would be used in the Regional Municipality's decision regarding the installation of piped water.

Methods

Three methods were used to determine whether the present water supply and sewage disposal system in the Parkway Belt area pose a threat to the health of its residents: assessment by public health inspectors, bacteriological and chemical analysesof water samples, and residents' responses to a health questionnaire. Public health inspectors made on-site visits to each residence in the community to observe the water supply and sewage disposal system. At the time of this visit the inspector took a sample of the water supply for testing, collected data on drinking water and sewage systems and determined who lived in the household. A questionnaire was later mailed to one randomly selected person in each household by the Department of Health Services. The study questionnaire also was distributed

to randomly selected households in other areas of the Town of Dundas which were used as the control group.

On-site Visits by Inspectors: Two inspectors gained access to 239 of the 241 residences in the Parkway Belt area. Two religious establishments and the business establishment were not included in the 241 locations. For each residence they completed a "On-Site Inspector's Report to Assess Water Supply and Sewage Disposal" Form (see copy in Appendix I). This Form was specially developed for this study and was designed to enable the inspector to record his observations. In order to determine the Form's ease of administration and to identify any ambiguities with its content and design it was pretested with ten households which did not have municipal water and sewage and were outside Dundas. The Form included information about: the residence (name of occupant, address and phone number); type and date when drinking water samples were taken; date when samples from ditch water and ponding and/or leaking sewage systems were taken; type of water supply systems on the property; the location of the water supply; if and how the water supply is treated; the type of sewage disposal system; the location of the system; the approximate distance between the sewage disposal system and the drinking water supply; method of disposing laundry waste; and date when occupant was notified about the laboratory results.

Water Testing: The drinking water samples were taken after running the water for three minutes and down-stream from water treatment appliances at the residence. All water samples were kept at three to four degrees centigrade and transported to the Provincial Public Health Laboratory within 24 hours from the time of taking the sample. Over 90 percent of the samples were submitted within six hours. Tests of total coliform, faecal coliform, pseudomonas aeruginosa, staphylococcus aereus, and streptococcus faecalis were performed in this laboratory. A sample of the water on the truck that brings water to the community was taken also. If the water source was a well, additional samples were sent to the Hamilton-Wentworth Regional Laboratory for the following chemical tests: ph, chloride, fluoride, iron, manganese, nitrate, sulphate, total dissolved solids, alkalinity, total hardness, and sodium. The Department of Health Services uses the Ministry of Environment (1982) bacteriological and chemical guidelines (see Appendix II) for classifying water as unsafe and/or unsatisfactory. These guidelines which are used by the Ministry of Environment to establish the need for piped water were used in this study. As is the custom of the Inspection Division, as soon as the water quality results were received back from the laboratory, a copy was sent to each household along with an explanatory letter (see Appendix III).

Questionnaire Survey: Residents of Parkway Belt were questioned about their health status to determine possible ill-health effects of their drinking water and sewage disposal systems. The choice of study design was made in the light of knowledge that: persons exposed to water with faecal contamination over a long period of time may be not report symptoms; absence of a list of the specific contaminants that the residents may have been exposed to in addition to those through ingestion of water; the difficulties in measuring low-dose chronic exposure to other pollutants; and, the lack of knowledge of their long term toxicological effects. The choice of design

was therefore guided by the hypothesis that the potential burden of ill-health attributable to unsafe water would be reflected in a measurable excess in the frequency and duration of symptoms, disability, acute and chronic health problems and health care utilization. Accordingly, a cross-sectional comparative design was selected, emphasizing the prevalence of symptoms known to be associated with enteric infections in a water supply (International Association of Milk, Food, and Environmental Sanitarians Inc. 1979) as a key outcome criterion.

A random sample of households in the other areas of the Town of Dundas was chosen as comparable (DC) to the Parkway Belt (PB) area in terms of sociodemographic, economic and life style (that is, smoking) characteristics but with a municipal water supply and sewers. Selection of the persons in the DC area was a two-stage process: 200 addresses were randomly selected Town of Dundas tax rolls and then four specially trained (see contents of training session in Appendix IV) enumerator/interviewers visited the households, obtained a list of all those living in the household and randomly selected one person in the household to be the person to complete the study questionnaire. For persons selected under 16 years of age, a parent was asked to complete the questionnaire from the perspective of the child. The enumerator/interviewer waited for the respondent to self-complete the study questionnaire. If the selected household member was not at home, the enumerator/interviewer left the study questionnaire with a self-addressed, stamped envelop for the selected household member to complete and return. An interviewer called back up to three times in an attempte to complete the questionnaires by telephone.

In the PB area households, the inspector enumerated all who lived in the households during their on-site visit and randomly selected one member who was 16 years and over to complete the study questionnaire. As the questionnaires had not yet been printed when the inspectors were visiting PB residences, the questionnaires and self-addressed, stamped return envelops were mailed to each household. A reminder post-card, a second copy of the questionnaire, and a telephone follow-up (with a maximum of three call-backs) was carried out for all those not returning completed questionnaires at two-weeks, three-weeks and six-weeks respectively after the initial mailing.

Health status was assessed using a self-administered questionnaire (see Appendix V), questions taken verbatim from the Canada Health Survey (Statistics Canada 1981) and the General Social Survey (Statistics Canada 1986). A telephone version of the questionnaire was used for subjects who did not return the self-completed version. A special section on the frequency and duration of symptoms potentially related to enteric infections, which we called cardinal symptoms, was added. Also the questionnaire had the same questions about drinking water and sewage disposal as on the inspector's "On-site" Form described above. The questionnaire took approximately 15 minutes to complete. It was pretested with ten persons in a community that did not have municipal water or sewers to determine length of time of completion and ease of self-administration. The survey in both the PB and DC areas was conducted between October and December 1986. The inter-rater agreement of the computer coding of

responses to 20 questionnaires was 98.6 percent.

Statistical techniques consisted of classical methods for crude analyses, namely Fisher's exact, chi-square and t tests, and of Mantel Haenzel (1959) chi-square methods for adjusted analyses.

Results

On-site Visits by Inspectors: The inspectors gained access to 239 of the 241 households in the Parkway Belt (PB) area. As only 227 water tests were available for this report, Table 1 only reports water sources for these residences. The types of water supplies and sewage disposal systems they observed in the PB area is summarized in Table 1. As shown here, the percent of residences with drilled wells was six (13 of 227) percent, dug wells 16 (37 of 227) percent, trucked water only 33 (75 of 227) percent, trucked water and rainwater 34 (78 of 227) percent, rainwater eight (18 of 227) percent, springfed two (four of 227) percent and artesian source one (two of 227) percent.

As shown in Table 2, the inspectors observed that 97 (232 of 239) percent of residences had septic tanks and two (five of 239) percent had holding tanks. One residence used an aerobic system, and one an outhouse. Overall there were 32 (77 of 239) percent of residences with sewage discharging into an open ditch. This discharging occurred in 32 (74 of 232) percent of residences with septic tanks, two of the residences with a holding tank and with the outhouse (25 feet from the house). One of the residences with a septic tank and one with a holding tank had sewage leaking or ponding according to the inspectors' observations. These are conservative estimates of these problems as the survey was conducted in the fall and not the spring of the year when sewage systems are more likely to fail.

Water Testing: The percent of residences with unsafe and/or unsatisfactory water according to Ministry of Environment guidelines for bacteriological and chemical testing was 89 (202 of 227). As shown in Table 1, the percent of residences with unsafe and/or unsatisfactory water which had drilled wells was 85 (11 of 13) percent, dug wells 100 (37 of 37) percent, trucked water only 88 (66 of 75) percent, trucked water and rainwater 82 (68 of 78) percent, rainwater 78 (14 of 18) percent, springfed 100 (four of four) percent and artesian well 100 (two of two) percent. Only two residences used a chlorinator and in both instances the water was safe. The water tests indicated that sewage (pseudomonas aeruginosa, staphylococcus aereus, and faecal streptococci -- see Appendix VII) is contaminating up to one half of the residences' drinking water.

The water from the delivery truck serving the Parkway Belt area was tested and the water was found to be safe.

Fifty-three (104 of 198) percent of the residents with unsafe and/or unsatisfactory water reported drinking this water. For those residences where the inspectors reported that there were problems with the sewage disposal, 53 (86 of 162) percent reported that they drank the water.

Questionnaire Survey: Of the 428 residences identified in the PB and DC areas during the ten week period of the survey, a total of 348 questionnaires were completed. This overall response rate of 81 percent ranged from 80 (193 of 241) percent in Parkway Belt (PB) area to 83 (155 of 187) percent in the Dundas control area (DC) (see Appendix VI). In the Parkway Belt area, 70 (135 of 193) percent of respondents indicated that they would like to have municipal water connected to their property. Table 3 shows that the survey respondents from each area were not comparable on some sociodemographic variables. Therefore adjusted analyses controlling for these age, sex and education level were performed. All three adjustment analyses had a substantial impact on the measures of effect but for purposes of brevity, only the age-adjusted analyses are reported here in detail with the detailed analyses included in Appendix VIII.

As indicated under Methods, cardinal symptoms were of special interest. The two-week prevalence of at least one of these five cardinal symptoms was 35 (67 of 190) percent for PB residents compared to 26 (40 of 153) percent of DC residents. That is, the crude relative risk of at least one or more cardinal symptoms in PB compared to DC was 1.3 (35 divided by 26). The age-adjusted relative risk is 1.5. This is neither statistically nor clinically significant. However, the two-week prevalence rates for stomach cramps were 20 percent and 11 percent in PB and DC respectively. This age-adjusted relative risk of 2.0 was declared clinically and statistically significant. Diarrhea was 2.6 (age-adjusted) times more likely to be reported by PB than DC respondents and this also was statistically significant. Chills were had an age-adjusted relative risk of 2.4 but this did not reach statistical significance.

In terms of all eight probed symptoms, a nonsignificant age-adjusted relative risk of 1.1 was found.

Because the number of PB residences with safe and/or satisfactory drinking was small (15 residences), comparisons of cardinal symptom reporting levels between those drinking safe and unsafe water was not statistically justified.

As shown in Table 5, reported long-term health problems, long-standing illness, disability or infirmity, bed disability days rates in the preceeding two weeks were similar (neither clinically nor statistically significant) in the PB and the DC area. For example, 25 (48 of 191) percent of PB residents reported one or more long term health problems compared to 26 (39 of 151) percent in DC residents. Debility or major activity loss (that is, work, school, domestic) in the two areas of comparsion was similar and was not statistically significant. Also, minor activity loss did not differ between the communities.

The two-week rates of use of any health professional were very similar for respondents in the two study areas.

Respondents were asked the global question "How would you describe your state of health? Compared to other persons would you say it

was...excellent, good, fair or poor?". The proportion of respondents reporting excellent or good health did not differ between the PB and DC areas. In addition, the respondents were asked the global question: "How would you rate your feelings about your health? very satisfied, somewhat satisfied, somewhat dissatisfied, very dissatisfied, no opinion". The proportion of respondents reported being very satisfied or somewhat satisfied did not differ between the PB and DC areas.

Conclusions

A large majority (70 percent) of the respondents in the Parkway Belt area indicated they would like to have municipal water connected to their property.

On-site Visits by Inspectors: The inspectors found that 67 (153 of 227) percent of the Parkway Belt (PB) residents have water brought to their homes by trucks. The overall percent of residences in the PB area with unsafe and/or unsatisfactory water was 89 (202 of 227) percent. The overall percent of households with sewage problems as reported by theinspectors was 32 (77 of 239) percent.

Consequently, while the provision of municipally piped water will eliminate the water quality and quantity problems in Parkway Belt, serious consideration must be given to the effect that an unlimited supply of water is likely to have on the existing subsurface sewage disposal systems.

Many homes in this area are located on undersized lots and the construction and installation of existing garages and swimming pools will preclude the possibility of expanding existing septic tank systems in a number of residences.

The potential exists that an increased use of water will result in existing septic tank systems becoming overloaded and malfunctioning thus precipitating a demand for municipally operated sanitary sewers.

Water Tests: Residents on properties in the PB area whose drinking water was tested were notified about the test results. Ongoing testing of water should continue until piped water is installed.

Questionnaire Survey: Table 5 shows a profile summary of the results of the health indicators comparisons between the PB and the comparison area (DC). These are health indicators that were chosen in advance for this survey. It is evident that for all but the cardinal symptoms. No clinical or statistical differences in the health indicators between the PB and the comparison area (DC) were found. Although the combined cardinal symptom age-adjusted relative risk was 1.5 and not statistically significant, two symptoms, diarrhea and stomach cramps, were clinically and statistically more frequently reported in PB than in DC. Consequently, it is concluded that the PB residents suffer from illnesses that may be attributable to bacteria in the water.

Discussion

The preparation and execution of this study had a high level of cooperation from Parkway Belt residents and members of the Dundas Town Council. Both groups agreed that the questions addressed by this study should be examined thoroughly before taking the next steps with the Regional Council of the Municipality of Hamilton-Wentworth and the Ministry of Environment. The high response rate to this survey further testify to the interest around the piped water issue in the Parkway Belt area.

Detecting subtle but clinically important differences of symptom rates or non-specific health complaints in a population exposed to unsafe water over a long period of time is an exceedingly difficult challenge.

The quality of the water in cisterns is particularly susceptible to variable bacterial water test results. When a tank is near empty it is more likely to be contaminated than when it is freshly filled. Immediately after a rainfall the water is more likely to be contaminated with debris from roofs or in the case of ground level cisterns contamination from sewage overflow. There was no attempt in this study to take the water samples and to administer the questionnaires when the cisterns were freshly filled when they are less likely to be contaminated or after rainfalls when they are more likely to be contaminated. In addition, the data collection forms used in this study did not obtain data on these factors thus preventing their examination in the analyses.

This study demonstrates that even in a non-experimental framework, careful design, exhaustive attention to detail in the field work, advance declaration of the findings that are clinically important and judicious selection of variables of greatest relevance can detect environmental problems such as the unsafe drinking water found in the Parkway Belt area.

The study is a model of a fruitful collaboration of the medical officer of health, the inspection division of the Department of Health Services, neighbourhood action groups of the community involved and university scientists. Not only can community health challenges be addressed with such cooperation, but it can be done both rigorously and expeditiously, even in major undertakings such as this one in the Town of Dundas, which was completed in less than seven months.

References

Committee on Communicable Diseases Affecing Man. Procedures to Investigate Waterborne Illness. International Association of Milk, Food, and Environmental Sanitarians, Inc. P.O. Box 701, Ames, Iowa, 50010. First Edition, 1979.

Department of Engineering. Personal communication with Conrad Brenner, The Regional Municipality of Hamilton-Wentworth Department of Engineering. January 1987.

Mantel N, Haenszel W. Statistical Aspects of the Analysis of Data from Prospective Studies of Disease. Journal of the National Cancer Institute. 1959; 22:719-748.

Ministry of the Environment. Water Management: Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment. Toronto, Ministry of the Environment, 1984.

Ministry of the Environment. Water Wells and Ground Water Supplies in Ontario. Toronto. Ministry of the Environment. 1982.

Statistics Canada. The Health of Canadians -- Report of the Canadian Health Survey. Catelogue Number 82-538E. Ottawa. Health and Welfare Canada and Statistics Canada. 1981.

Statistics Canada. General Social Survey, Ottawa, Housing, Family and Social Statistics Project. Statistics Canada, 1986.

UMA Engineering. Water Impact Study on Existing Residences within Parkway Belt Area, Town of Dundas. UMA Engineering Ltd. 83 Carlingview Drive, Rexdale, Ontario. Prepared for The Regional Municipality of Hamilton-Wentworth, Planning and Development Department. 1985.

Underwood McLellan. Hydrology Sub-Study for Parkway Belt West Study Area, Town of Dundas. Underwood McLellan Ltd. 89 Carlingview Drive, Rexdale, Ontario. Prepared for The Regional Municipality of Hamilton-Wentworth, Planning and Development Department. 1984.

TABLE 1: QUALITY OF WATER SOURCE N PARKWAY BELT BY TYPE OF SOURCE (N=227)

WATER SOURCE	RESIDENCES % (N)	RESIDENCES WITH UNSAFE WATER ROW %
DRILLED WELL	6 (13)	85 (11/13)
DUG WELL	16 (37)	100 (37/37)
TRUCKED WATER (CISTERN)	33 (75)	88 (66/75)
TRUCKED & RAIN WATER (CISTERN)	34 (78)	87 (68/78)
RAINWATER (CISTERN)	8 (18)	78 (14/18)
SPRINGFED	2 (4)	100 (4/4)
ARTESIAN WELL	1 (2)	100 (2/2)
T O T A L	100 (227)	89 (202/227)

* WATER TESTING NOT COMPLETED FOR 12 RESIDENCES

TABLE 2: TYPES OF SEWAGE DISPOSAL IN PARKWAY BELT AREA

SEWAGE DISPOSAL	RESIDENCES	SEWAGE PROBLEM	PONDING OR LEATCHATE
	% (N)	ROW %	ROW %
SEPTIC TANK	97 (232)	32 (74/232)	0 (1/232)
HOLDING TANK	2 (5)	40 (2/5)	20 (1/5)
AEROBIC SYSTEM	0.5 (1)	0 (0)	0 (0)
OUTHOUSE	0.5 (1)	100 (1/1)	0 (0)
T O T A L	100 (239)	32 (77/239)	0 (2/237)

TABLE 3

COMPARISON OF PARKWAY BELT RESIDENTS (PB) WITH DUNDAS CONTROLS (DC) BY SOCIO-DEMOGRAPHIC AND LIFESTYLE VARIABLES

	PB %	DC %	Stat. Test	P
Mean Age (years)	40 (N=193)	43 (N=153)	1.02	0.307
Female (%)	39 (N=193)	51 (N=154)	5.36	0.021
Median Length of Residence (years)	11 (N=194)	5 (N=152)	2.58	0.010
Own Property (%)	81 (N=157)	68 (N=154)	8.21	0.004
Main Activity (%)	(N = 194)	(N = 154)		
Working	49	42		
Keeping House	17	22		
Going to School	12	13	5.30	0.505
Retired	13	13		
Child/Baby	7	6		
Other	2	4		
Missing	--	--		
Level of Education (%)	(N = 194)	(N = 154)		
No Schooling	6	7		
Some Public	12	12		
Completed Public	14	5		
Some High School	19	12	17.30	0.016
High School Dip	14	24		
Some Coll/Univ	8	12		
Coll/Univ Degree	14	20		
Other	8	7		
Missing	3	1		
Cigarette Use (%)	(N = 194)	(N = 154)		
Never Smoked	39	46		
Former Smoker	26	26	5.30	0.505
Current Occasional Smoker	2	1		
Current Daily Smoker	23	19		
Unknown	10	8		

*(N=NUMBER RESPONDING TO QUESTION)

TABLE 4

COMPARISON OF PB WITH DC BY TWO-WEEK PREVALENCE OF SPECIFIC CARDINAL (FOR ENTERIC INFECTIONS) AND OTHER SYMPTOMS

	PARKWAY BELT	DUNDAS CONTROL			
N	%	%	RR*	x^2	P
STOMACH CRAMPS	20 (38/190)	11 (17/153)	1.8	4.34	0.037
CHILLS	11 (20/190)	5 (7/153)	2.2	3.36	0.067
DIARRHEA	26 (49/190)	12 (18/153)	2.2	9.73	0.002
CONSTIPATION	7 (14/190)	7 (10/153)	1.0	0.01	0.930
FEVER	8 (15/190)	8 (13/153)	1.0	0.00	0.997
ONE OR MORE OF CARDINAL SYMPTOMS	35 (67/190)	26 (40/153)	1.3	2.87	0.901
COUGH	20 (38/190)	20 (31/153)	1.0	0.00	1.000
VOMITING	4 (7/189)	4 (6/153)	1.0	0.00	1.000
STIFFNESS IN JOINTS	32 (46/190)	22 (33/153)	1.5	0.20	0.654
ONE OR MORE OF EIGHT SYMPTOMS	53 (101/190)	51 (78/153)	1.0	0.60	0.810

*AGE - ADJUSTED RELATIVE RISK

TABLE 5

PROFILE OF HEALTH STATUS INDICATORS IN (PB) VERSUS COMPARISON AREA (DC)

	PB % (N)***	DC % (N)***	RR**	x^2	P-VALUE
One or More of Cardinal Symptoms	35 (190)	26 (153)	1.3	2.87	0.090
One or More of Eight Symptoms	53 (190)	51 (152)	1.0	0.06	0.809
Reported Long-Term* Health Problems	25 (191)	26 (151)	1.0	0.02	0.894
Reported Long-Standing* Illness, Disability or Infirmity	14 (191)	18 (151)	0.7	0.76	0.383
Bed Disability*	8 (188)	9 (151)	0.9	0.05	0.820
Debility (Major Activity Loss)*	10 (191)	11 (153)	0.9	0.92	0.631
Minor Activity Loss*	8 (191)	13 (154)	0.6	2.12	0.145
Use of Physicians and Health Practitioners (Two Weeks)	34 (191)	37 (152)	0.8	1.83	0.66
Reported State of Health	(N=194)	(N=154)			
(1) Excellent	28	38			
(2) Good	59	46			
(3) Fair	11	14			
(4) Poor	2	2		-5.718	0.126
(5) Missing	0	0			
Feelings, re: Health	(N=194)	(N=154)			
(1) Very Satisfied	43	52			
(2) Somewhat Satisfied	44	30			
(3) Somewhat Dissatisfied	9	11		7.84	0.097
(4) Very Dissatisfied	2	3			
(5) No Opinion	2	4			
(6) Missing	0	0			

* See Appendix IX for Definitions
** Age-Adjusted
*** Number Responding to Question